Space Weather Technical Forecast

Issued on Tuesday 26 November 2024 at 01:29 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate to High Solar Activity expected with a slight chance of X-flares. Increasing chance of higher Geomagnetic activity in the coming days.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with numerous M-class flares observed in the past 24-hours and with a peak M9.4 flare at 25/0742 UTC from an as yet unnumbered region close to the northeast limb.

There are currently ten sunspot regions on the visible disc. AR3906 (Eki/Beta-Gamma-Delta), the largest group, located in the southeast, was the most active flare producing region, with a complex magnetic configuration that includes a small delta spot. The region increased in size, with the emergence of new spots, especially within its intermediate portion. AR3905 (Eki/Beta-Gamma), nearby, is also a large, magnetically complex sunspot group, but some simplification was observed in its magnetic structure as its small delta spot decayed. Its intermediate spots also tended to decay and separate during the period. Minor growth was seen in AR3907 (Cao/Beta) in the southwest near centre-disc. AR3901 (Hax/Alpha) also in the southwest, decayed to a mature unipolar group, but still produced an M1.9 flare at 25/2054 UTC. The remaining groups on the disc are smaller and more magnetically simple. Ex-AR3879, a large region, last on the visible disc in early November started to rotate into view over the northeast limb, but is as yet unnumbered.

There are considered to be up to three CMEs during the past 24-hour period of note with potential Earth-directed effects, pending further analysis and modelling. The first two CMEs left the Sun in quick succession early on 25 Nov from the southeast disc. The first of these has been attributed to the M1.1 flare of AR3906 at 25/0159 UTC, followed by a large filament eruption around 25/0230 UTC. Initial modelling suggests that the bulk, if not all of the ejecta is directed south and east of the Earth-Sun line. Perhaps more significantly, a filament eruption starting around 25/2030 UTC close to AR3901 led to an M1.9 flare and marked coronal dimming, along with a Type II Radio Emission (Estimated Velocity 490km/s). At the time of writing we are awaiting LASCO C2/C3 coronagraph imagery to backfill in order to confirm if an Earth-directed CME has resulted from this. However, it appears likely that this is the case given the source location of the event on the disc.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE at L1 varied between Background and Slightly Elevated levels, due to minor fast-wind influence from CH94/- in the southwest disc, but this slowly declined during the period. The Interplanetary Magnetic Field, Bt, was Weak to Moderate, peaking at 8nT at 25/0158 UTC. The north-south component of the IMF

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varied weakly between +7/-7nT, with frequent deviations between positive and negative Bz observed. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 remained at Background levels. High energy electron flux (greater than 2MeV) observed by GOES16 varied between Background and Moderate levels. The associated 24-hour fluence remained well below the Active threshold. The integrated flux observed at 26/0000 UTC was 1.12e6.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Moderate to High with occasional M-flares expected and a slight chance of isolated X-class flares occurring, primarily from AR3905, AR3906 or Ex-AR3879.

Solar Wind / Geomagnetic Activity: Three CMEs that left the Sun on 25 Nov are being analysed for potential Earth-directed components. Of these, the third, that left the Sun late on 25 Nov from the southwest disc is most likely to affect Earth towards the end of the forecast period, however, further imagery and analysis is required to confirm this.

Solar wind speeds are currently varying between Background and Slightly Elevated levels due to an ongoing, but declining connection to a small coronal hole in the southwest disc. This enhancement is expected to further wane on Day 1 (26 Nov) with solar winds expected to become persistently Background. No other significant recurrent or fast wind enhancements are forecast during the period.

Geomagnetic activity is expected to be mainly Quiet to Unsettled through the period, but with a slight chance of peak G1/Minor Storm conditions on Day 4 (29 Nov). Please note that probabilities will likely change for the end of the period once the various CMEs currently under analysis have been confidently modelled.

Energetic Particles / Solar Radiation: High energy protons are expected to persist at Background levels, with a slight but increasing chance of Solar Radiation storms occurring during the period, mainly from the large sunspot regions in the southeast. High energy electron flux has been at Background to Moderate levels and is expected to persist at these levels initially, but with diurnal increases to High flux possible, more especially later in the four-day period. Despite this associated 24 hour fluence is expected to persist below the Active threshold, but with a rising trend likely in the coming days.

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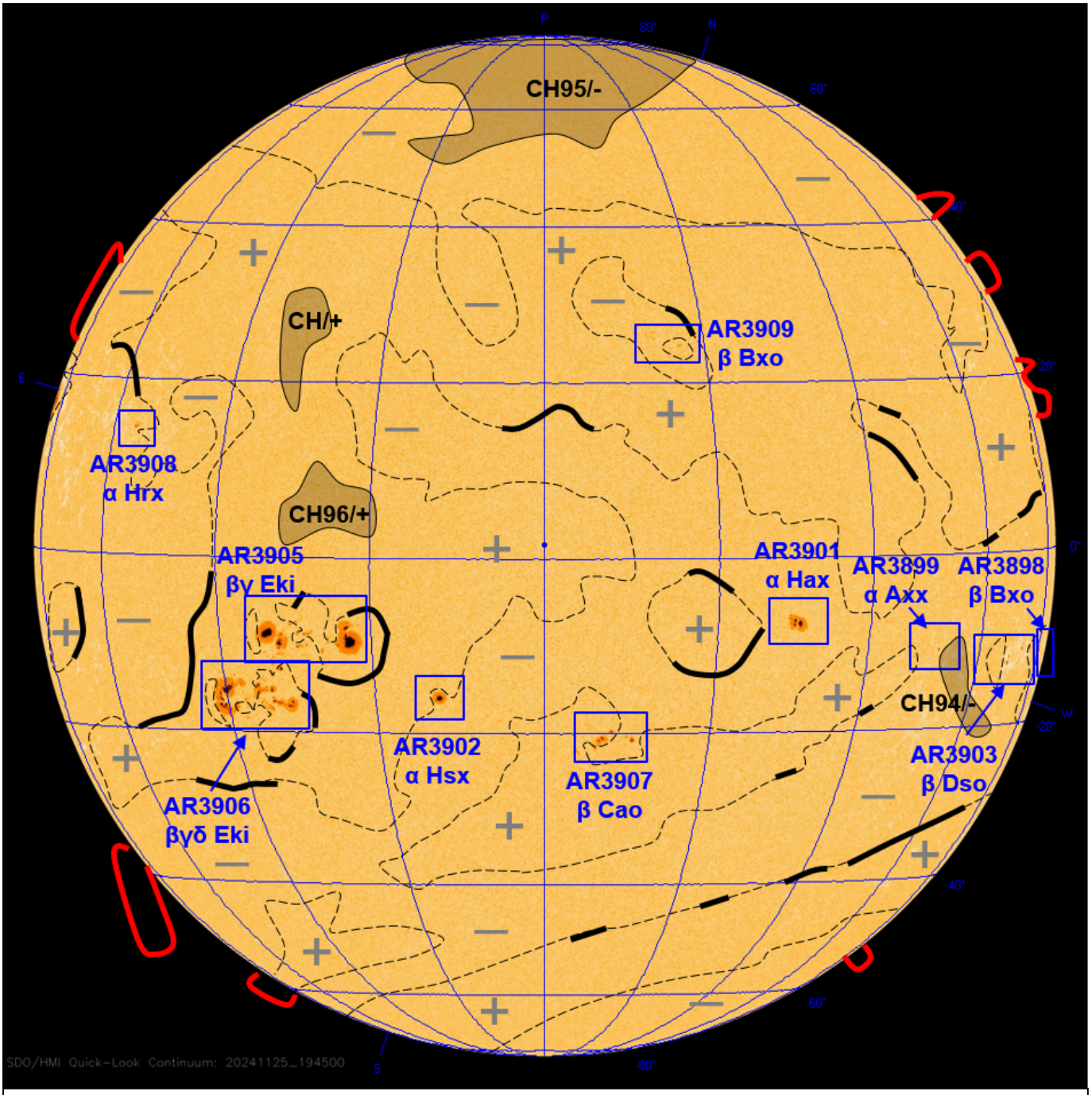
Figure 1: MOSWOC Solar Synoptic Map valid 25/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Numerous CMEs have left the Sun in recent days, reducing confidence in the analysis of individual events, however, there are considered to be three events of note with potential Earth-directed effects, pending further analysis and modelling. The first two CMEs left the Sun in quick succession early on 25 Nov from the southeast disc. The first of these has been attributed to the M1.1 flare of AR3906 at 25/0159 UTC, followed by a large filament eruption around 25/0230 UTC. Initial modelling suggests that the bulk, if not all of the ejecta is directed south and east of the Earth-Sun line, however, some slight Earth-directed component and glancing impact from these slow CMEs cannot completely be ruled out to arrive on Day 4 (29 Nov). Perhaps more significantly, a filament eruption starting around 25/2030 UTC close to AR3901 led to an M1.9 flare and marked coronal dimming, along with a Type II Radio Emission (Estimated Velocity 490km/s). At the time of writing we are awaiting LASCO C2/C3 coronagraph imagery to backfill in order to confirm if an Earth-directed CME has resulted from this. However, it appears likely that this is the case and Geomagnetic Storm probabilities later in the forecast period are expected to be updated later today (26 Nov) once this event has been confidently modelled.

Solar wind speeds are currently varying between Background and Slightly Elevated levels (between 380-420km/s) due to an ongoing, but declining connection to the HSS of small CH94/- in the southwest disc. This enhancement is expected to further wane on Day 1 (26 Nov) with solar winds expected to become persistently Background. No other significant recurrent or fast wind enhancements are forecast during the period. MOSWOC Enlil model output continues to significantly over estimate solar wind speeds, and is considered likely to be too fast until Day 4 (29 Nov).

Geomagnetic activity is expected to be mainly Quiet to Unsettled through the period, but with a slight chance of peak G1/Minor Storm conditions on Day 4 (29 Nov). Please note that probabilities will likely change for the end of the period once the various CMEs currently under analysis have been confidently modelled.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	1	1	1	20
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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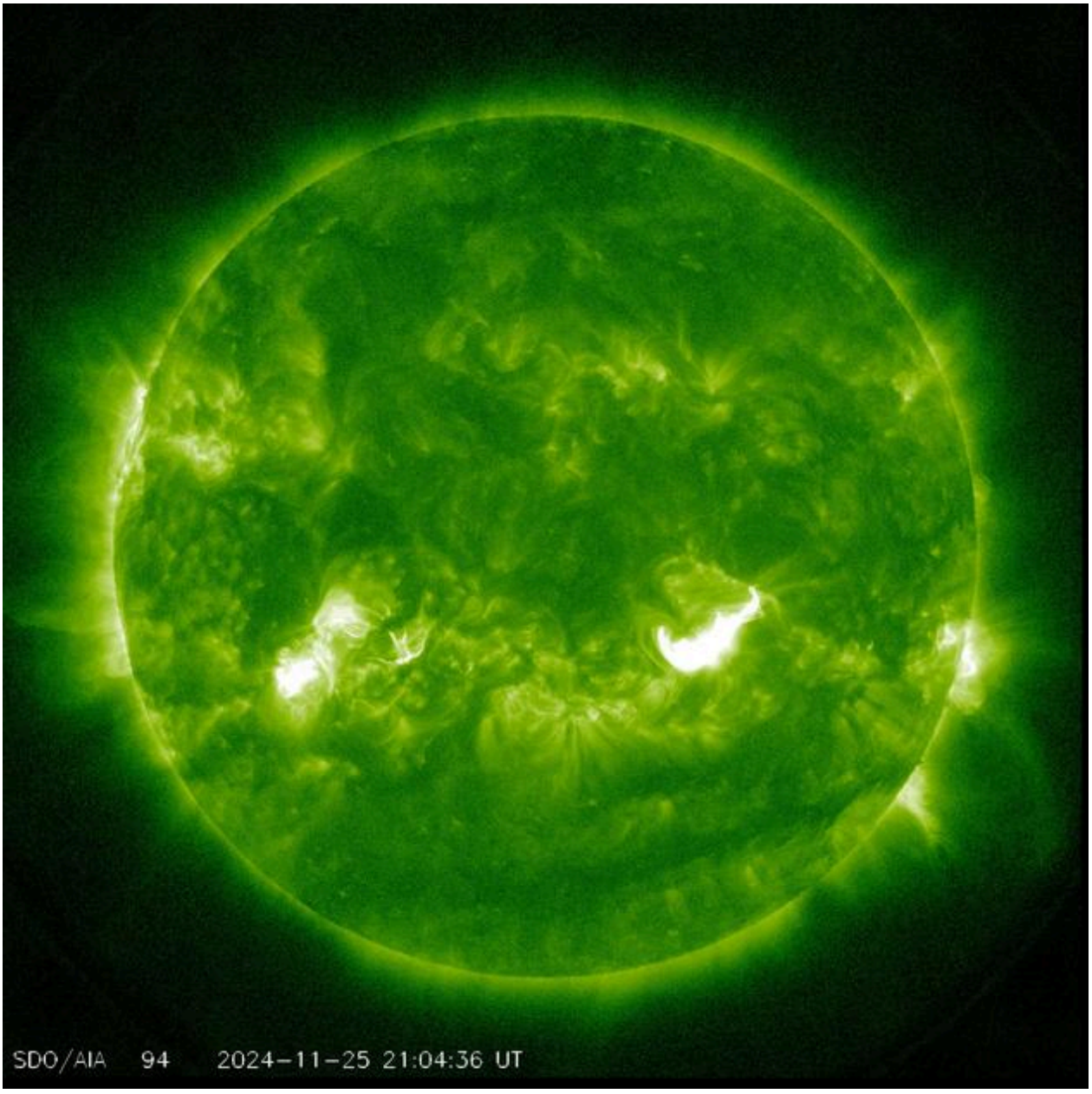
Figure 2: SDO/AIA 94 imagery at 25/2104 UTC. Note the bright flux from AR3901 in the southwest disc following the filament eruption and potential Earth-directed CME.



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Radio Blackouts - X-Ray Flares

There are currently ten active regions on the visible disc with numerous M-class flare observed in the past 24-hours and with a peak M9.4 flare at 25/0742 UTC from an as yet unnumbered region close to the northeast limb. At this time the largest and most complex regions on the visible disc are located in the southeast quadrant (AR3905 and AR3906) and are in close proximity to each other. Both AR3905 and AR3906 contain moderately-large lead and trailing spots with continued slow evolution and shearing of their intermediate, mixed polarity spots. A weak delta spot that was previously present in the intermediate portion of AR3905 has decayed, however, the small delta spot within AR3906 persists. A new, large region is emerging over the northeast limb, but is too foreshortened in imagery to make a confident assessment of its classification at present. This is Ex-AR3879, last on the visible disc in early November as a large, mature spot, although preliminary indications from coronagraph imagery is that there has been some spot emergence since it was last on the visible disc.

All current major flare risk regions remain on the visible disc through the forecast period.

Solar activity is forecast to be Moderate to High with occasional M-flares expected and a slight chance of isolated X-class flares occurring, primarily from AR3905, AR3906 or Ex-AR3879.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	75	75	75	75
Very Active	R3-R5 (X Class)	No	15	15	15	15

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Figure 3: HMI Intensitygram (left) and HMI Colorized Magnetogram (right) imagery of AR3905 and AR3906 at 26/0100 UTC.

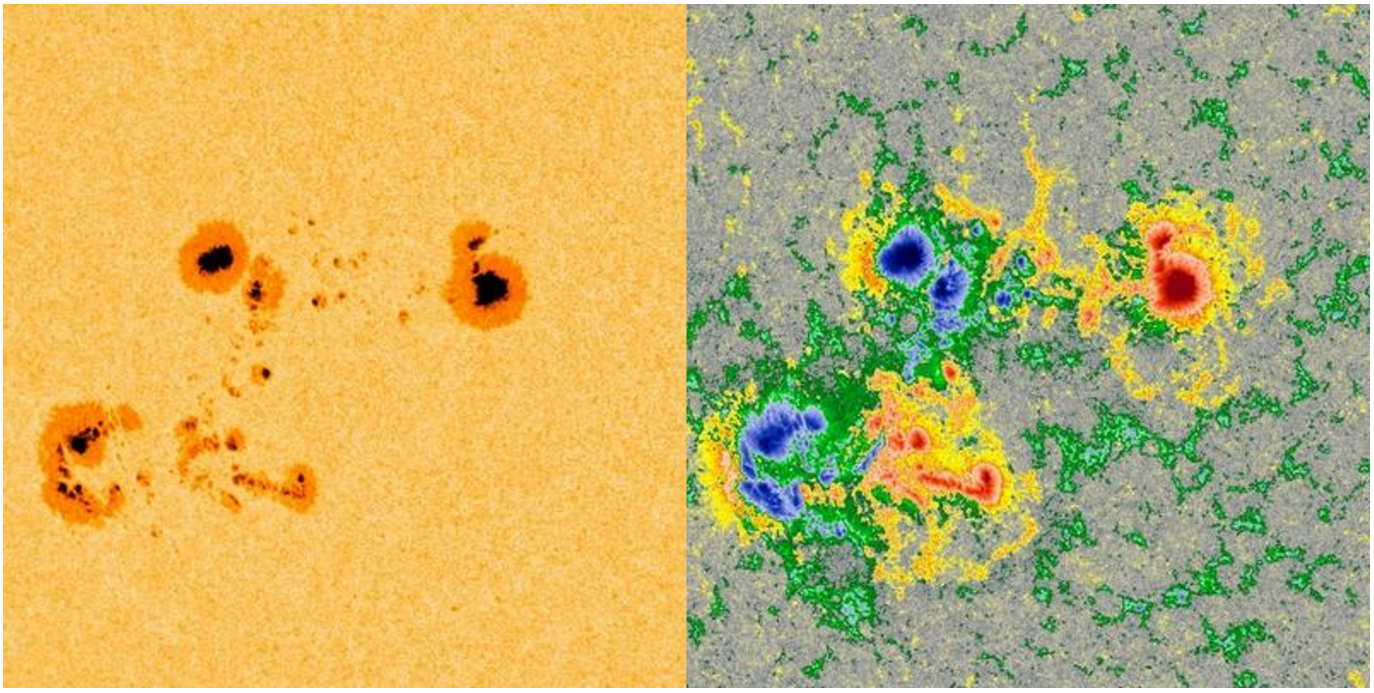
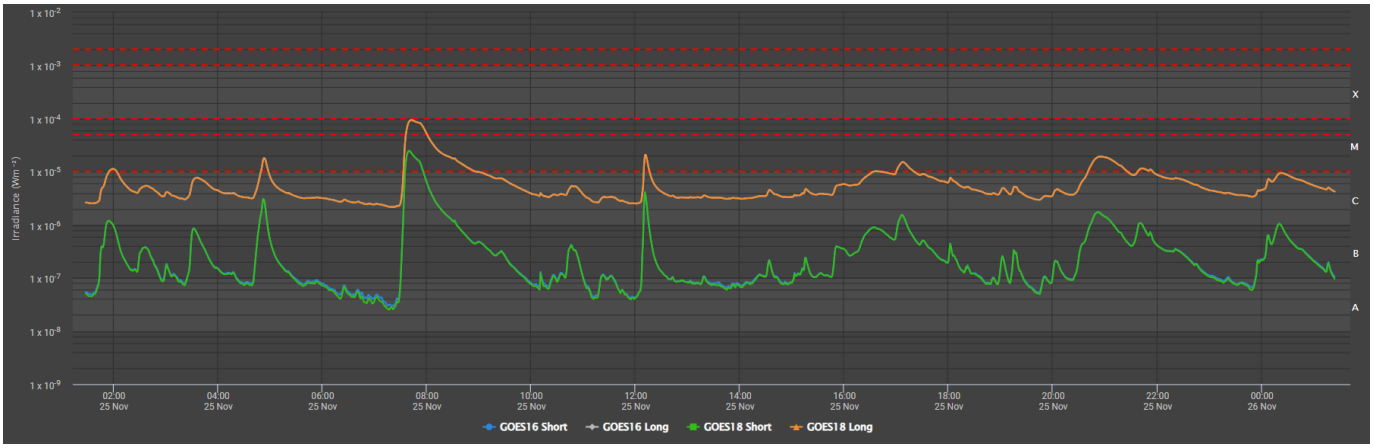


Figure 4: Latest GOES16/18 X-Ray flux trace.



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Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at Background levels. The main regions currently on the visible disc which are most likely to produce proton enhancements are AR3905 and AR3906, both located in the southeast quadrant. From this position on the disc any proton enhancements are less likely to significantly affect Earth, but as they rotate towards and then beyond centre disc in the coming days that risk increases marginally. Subsequently, observed proton flux is expected to persist at Background levels, with a slight but increasing chance of Solar Radiation storms occurring.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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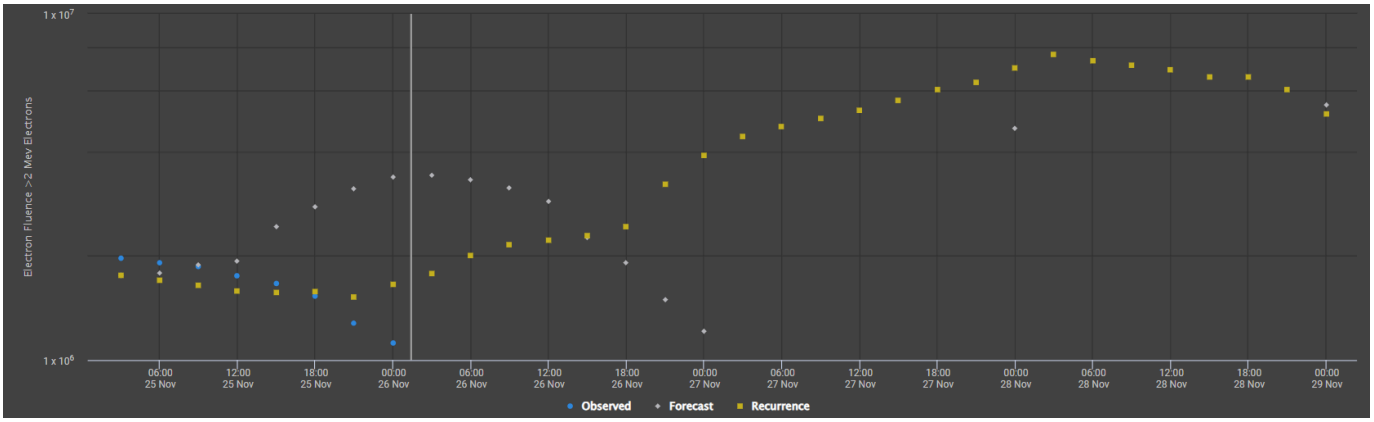
High Energy Electrons (≥ 2MeV)

Electron flux observed by GOES-16 has been at Background to Moderate levels and is expected to persist at these levels initially, but with diurnal increases to High flux possible, more especially later in the four-day period following the easing of the HSS from CH94/-. Increases in electron flux late in the forecast period may become suppressed again, pending analysis and modelling of various CMEs that left the Sun on 25 Nov.

Associated 24 hour fluence is expected to persist below the Active threshold, but with a rising trend likely in the coming days and MOSWOC REFM output thought to be providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: Latest MOSWOC REFM output and Recurrence forecast.



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